THURSDAY, MAY 11, 1876

THE LOAN COLLECTION

THE Queen will on Saturday open to the public the magnificent collection of scientific instruments, the arrangement of which has for several months been tasking the energies of the Science and Art Department and of the eminent men of science who have generously volunteered their assistance. This event may justly be regarded as an "epoch-making" stage in the progress of science, not only in this country, but in the world at large; for, as our readers know, the collection is essentially an international one, the principal nations of the world having vied with each other in contributing to render it worthily representative of the present state of science, and of the progress of its methods from the time when man first began feebly to question Nature. England may well be proud that the idea of such a collection originated with the English Science Department, and that the first international scientific loan collection will be exhibited in her capital. It may be that this collection will not attract such a crowd of visitors as would flock to gaze on an exhibition of pictures, or musical instruments, or embroidery, or old china; but, if the British public still retains its normal amount of curiosity, surely the magnitude of the present collection, the historical interest attaching to many of the objects exhibited, the number and eminence of the contributors, and the fact that the principal governments of Europe have enthusiastically seconded the efforts of the British Government, ought to excite that curiosity to the utmost. A great deal of mystery still hangs about science and scientific men and scientific methods in the eyes of many; here then at last have people an opportunity of inspecting for themselves these mysterious instruments by means of which men of science have reached those results that are stirring the minds of all thoughtful men, and have revolutionised ideas and methods in all departments of human activity. Englishmen must be duller and more incurious than we take them to be, if they do not show a fair amount of interest in that scientific collection which her Majesty will open on Saturday.

But while many, no doubt, will be attracted to the galleries of the International Collection by mere curiosity, we are sure that the scientific education of this country is sufficiently advanced to secure a large proportion of visitors animated by an intelligent and educated eagerness to gratify their scientific tastes by inspecting apparatus the importance and uses of which they are well enough taught to appreciate. Both to this latter class and to those who still lie in unscientific darkness, the two thick volumes[1] which have been issued—prepared at the request of the Lords of the Committee of Council on Education—as guides to the Loan Collection ought to be a welcome boon. Some idea of the extent of the collection may be obtained from the fact that these two volumes together number nearly 1,000 pages, and they are both at present incomplete. With these in his hands as guides no visitor need go empty away from the collection. A careful perusal of these two volumes combined with a systematic series of visits to the various sections of the collection, would, like the acquaintance of a certain noble lady, be in itself a liberal education; and indeed few better methods could be devised of rousing a love for science in the minds of intelligent people.

In two previous articles we have attempted to give a general sketch of the nature of the collection; in the present article we shall, with the two volumes referred to as guides, briefly give some idea of its extent and arrangement. The large Committee—and there is scarcely a scientific name of eminence absent from it—that met little more than a year ago at the request of the Lords of the Committee of Council on Education to confer on the organisation of a Loan Collection of Scientific Apparatus ought to be proud of the results of that first conference as embodied in these two valuable publications. The names on this Committee, and those on the Committees formed in foreign countries, number somewhere about 300; a glance at the lists shows that the names are those of the foremost scientific workers of our time. Specially gratifying must the result be to the staff of volunteers who have assisted in the arrangement of the collection, and whose names their Lordships justly record with "great satisfaction." They are: Capt. Abney, Dr. Atkinson, Mr. Bartlett, Dr. Brunton, Dr. Biedermann, Prof. Crum-Brown, Capt. Fellowes, Prof. Carey-Foster, Dr. Michael Foster, Herr Kirchner, Prof. Goodeve, Dr. Guthrie, Commander J. A. Hull, Mr. Iselin, Mr. Judd, Mr. Norman Lockyer, Dr. R. J. Mann, Mr. Clements Markham, Prof. H. MacLeod, Prof. Roscoe, Prof. Shelley, Dr. Burdon Sanderson, Dr. Schuster, Dr. Voit, and Mr. R. Wylde.

Their Lordships, we should say, are particular in calling attention to the fact that this is not an International *Exhibition;* the purpose and arrangement of this collection are entirely different from those of such an exhibition, which is always arranged according to countries and into which the commercial element largely enters. The arrangement here, on the contrary, is according to subjects, and the object is solely to illustrate the history and present condition of scientific apparatus. The transport of all objects has been undertaken by the English Government, and they have been handed over absolutely to the custody of the Science and Art Department.

Prefixed both to the Catalogue and the Guide is a clear and useful plan of the buildings at Kensington, showing the arrangement of the apparatus in the various galleries. Fourteen galleries in all are occupied with the collection, embracing the ground floors of the entire south and west sides, and the upper floor of the latter. Entering, as the Queen will do on Saturday, by the entrance in Exhibition Road, we come first upon A, the Educational Collections; following which are B, C, Applied Mechanics; D, Naval Architecture and Marine Engineering; E, Lighthouse Apparatus; F, Magnetism and Electricity; G, Arithmetic and Geometry; H, K, Measurement; L, Astronomy and Meteorology; these are all on the ground floor. Ascending to the upper floor, we pass through M, Geography, Geology, and Mining; N, Biology; O,

[1] "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum." First Edition.—"Handbook to the Special Loan Collection of Scientific Apparatus." 1876.

Conference Room; P, Chemistry; Q, Light, Heat, Sound, and Molecular Physics.

The number of exhibitors—governments, societies, departments, and individuals—amounts to about 1,000, and the collection contains altogether somewhere about 15,000 objects, arranged in this first edition of the catalogue, under 4,576 heads. The countries represented are the United Kingdom, Austro-Hungarian Empire, Belgium, France, Germany, Holland, Italy, Norway, Russia, and Switzerland. The list from Spain is not yet received, and the fact that America is occupied with her own Centennial Exhibition sufficiently accounts for her absence, though the American Government heartily sympathises with the object of the collection. In the catalogue the objects are arranged under twenty-one sections; the numbers enable the visitor at once to identify each object or group of objects, and in most cases the appended descriptions are sufficiently detailed to enable anyone to understand the purpose and construction of the apparatus. In many cases the descriptions are as minute as in a special text-book.

Under Section 1, Arithmetic, are described various Slide-rules, 19 in all, 26 Calculating Machines, including Babbage's famous "Difference Engine," which is described in considerable detail, besides some interesting and ingenious miscellaneous apparatus. Under Section 2 are classed instruments used in Geometrical Drawing, Instruments for tracing Special Curves, Models of Figures in Space, and a collection of Plücker's models of certain quartic surfaces, contributed by the Mathematical Society.

As might be expected in a collection of scientific apparatus, those connected with Measurement, Section 3, occupy a large space: there are upwards of 350 entries under this head, comprising, besides a variety of extremely interesting and curious special collections, apparatus for Measurement of Length (nearly 100 entries) of Area, of Volume, of Mass, of Velocity, of Momentum, of Force, of Work, of Angles, and of Time (80 entries); many of the objects in this section are of a remote antiquity, and not a few are connected with scientific discoveries of the highest importance.

Section 4, Kinematics, Statics, and Dynamics, is a very full and instructive one; it is impossible to give here anything like an idea of the nature and variety of the apparatus exhibited under this head. It contains 22 sub-sections and sub-sub-sections, including several of 'sGravesande's apparatus, apparatus illustrating the Mechanical Powers, Pendulums and Gyroscopes, Vibrations and Waves, Falling Bodies and Projectiles, and other departments of the very comprehensive section, including 54 Crank Trains, 50 Toothed-wheel Trains, and 67 Ratchet Trains.

To many, Section 5, Molecular Physics, will be intensely interesting; its six sections contain 110 entries; the Air-pumps and Pneumatic Apparatus alone numbering 44. Osmose Dialysis and Diffusion, Condensation of Liquids and Solids, and Hydrometers, are some of the other subjects illustrated here.

Sections 6, 7, and 8, Sound, Light, and Heat, are of course among the most important, the catalogue containing 410 entries under these heads. There are apparatus illustrating the Sources, Measurement, and Interference of Sound, and a variety of other phenomena, including Musical Sounds; in Section Light, under the head Selectors, there are 36 groups of apparatus connected with the Spectroscope, and 30 to illustrate Polarisers, besides Photometers, Radiometers, apparatus bearing on Reflection, Refraction, and Diffraction. Photography is a varied and interesting sub-section. The multitude of apparatus connected with Heat is classified under Sources of Heat, Thermometry (56 entries), Calorimeters, Pyrometers, Freezing Machines, Conductors, &c.

Sections 9 and 10, Magnetism and Electricity, are likely to prove two of the most attractive, as they are certainly among the most important. All departments of these subjects—and how varied they are even scientific men may be astonished to learn—are illustrated with great fulness; the number of entries in the Catalogue is 650, commencing with the greatest natural magnet yet known, weighing, with armature, 152 kilograms, sent by the Teyler Foundation, Haarlem, and concluding with a minute description of the Polar Light Apparatus, by Prof. Lemström. Of apparatus connected with Electricity the variety is astounding. Friction and Induction Machines, Galvanic Batteries (there are 32), Thermo-Electric Batteries, Induction Coils, Magnetic-Electric Machines, and other modes of producing Electricity or Electric Currents, are abundantly represented. So, also, apparatus for producing, collecting, observing, regulating, and measuring electricity; of Galvanometers alone there are 43. In the Electrical Section, no doubt the most attractive department to the general public will be that devoted to apparatus for the application of Electrical principles to practical purposes, illustrating, as it does, every stage in the progress of the Electric Telegraph. The Catalogue in this department contains 204 entries of Telegraphic apparatus alone, not to mention the various other applications of electricity to military and other purposes.

Astronomy, Section 11, is at the same time one of the oldest and one of the most popular of the sciences, and therefore the apparatus in the section will probably have more than an average number of visitors. The historical interest of this section is probably greater than that of any other, and it is significant of the importance attached by Italy to this Collection that she has parted with, even for a short time, those precious relics of Galileo that cannot fail to excite the veneration of all beholders. But besides these there are many other instruments of great historical interest, from the Suspension Astrolabrum, made in 1525, sent by Prof. Buys Ballot of Utrecht, down to the latest form of spectroscope, and a relief landscape of the moon. Celestial photography is largely represented, both by its instruments and results, and teachers will be much interested in the varied and ingenious apparatus that have been devised for the practical teaching of astronomy.

Of the multitude of objects in Section 12, Applied Mechanics, it would be impossible with our space to give any satisfactory idea. The catalogue contains under this head 470 entries in all, many of which, as indeed is the case in all the other sections, include a considerable number of separate pieces of apparatus. Of Prime Movers alone there are 66 groups, ranging through many forms from a collection of the Original Models of Steam Engines and other machines of James Watt, downwards.

Under the comprehensive head of Application of the Principles of Mechanics to Machinery, as employed in the Arts, the catalogue gives a description of 136 varieties of apparatus, from the first type-composing machine invented by Alex. Mackie, which comes from Dundee, down to the latest forms of link-work.

Chemistry, Section 13, is of course one of the most prominent and important sections in the whole collection. When we say that the catalogue contains 360 entries under this head, we give very little idea of the multitude and variety of objects which have been brought together to illustrate the methods and results of the all-pervading science. The first entry is the apparatus employed by John Dalton in his researches, and is accompanied by a long descriptive and historical notice by Prof. Roscoe. Cavendish, Davy, Faraday ("Original tubes containing gases liquefied by Faraday," must be an exciting entry to many chemists), Wollaston, are names attached to some of the apparatus of historical interest; of Models, Diagrams, Apparatus, &c., employed in teaching Chemistry there is no end, and all the infinite variety of special chemical apparatus is amply illustrated, there being upwards of 200 entries under this head, representing probably more than ten times that number of separate objects.

The rapid advances and present complexity and comprehensiveness of Meteorological science are shown by the catalogue to be illustrated with wonderful fulness in the collection. The endless variety of Barometers, Thermometers, Anemometers, Rain-gauges, Hygrometers, Self-recording Instruments, Ozonometers, and other apparatus used in meteorology, will excite the astonishment of all but specialists. The Scottish Meteorological Society is a large contributor in this section, and some of their intensely practical graphic results must appeal to the blindest utilitarian.

Geography is sure to be a popular section, and we can only say that in its various sub-divisions are objects calculated to rouse the interest of the most incurious. The methods, apparatus, and results of the various surveys of this country and of India are illustrated in the greatest detail, and now that the *Challenger* is nearing our shores, many will be curious to see some of the apparatus with which her important ocean-researches have been conducted. There is a vast variety of surveying apparatus with which Geography obtains her apparently simple results, and of Maps, Charts, and Plans of all kinds the list is endless. Everyone must inspect with very curious feelings the original Journals, Log-books, &c., kept by celebrated English navigators from Dampier downwards, not to mention the valuable MS. Maps of Livingstone and other celebrated explorers.

Geology, Mining, and Mineralogy, Sections 16 and 17, are well represented. They include Geological Instruments and Apparatus; Maps, Sections, Diagrams, &c., lent by the Geological Survey; illustrations of the Sub-Wealden boring; various Relief-maps and Models illustrating Geological Phenomena all over the world; Fossils and Specimens of all kinds, natural and artificial; Mining Instruments and accessories, including a case of 46 varieties of Safety-lamp; Blowpipe Apparatus; Minerals, Diagrams, Models of Crystals, &c.

The Section of Biology has 500 entries, embracing probably eight times that number of separate objects. Of microscopes and accessory apparatus, there are upwards of 150 from the Compound Microscope of Zacharias Janssen, spectacle-maker, at Middleburg, Netherlands, constructed about 1590, down to the latest and most complicated form of this now indispensable and powerful instrument. Then there are many specimens of the curious and ingenious apparatus employed in Physiological Optics, Weighing and Measuring Apparatus, Apparatus for investigating the functions of Circulation and Respiration, of Muscles and Nerves, and an endless variety of Diagrams, Models, Preparations, and other appliances for instruction in Biology. Wolf's Collection of 106 Original Water-Colour Drawings illustrating the new and rare animals in the Zoological Gardens will prove nearly as attractive as the originals themselves.

Under Educational Appliances, Section 19, there are apparatus for practical instruction in Science in every department, including a very fine and large collection of apparatus for instruction in Physical Science, contributed by the Committee of the Pedagogical Museum, Russia. This section contains upwards of 550 entries.

Last of all comes the Collection of Apparatus and Photographs illustrating Italian Science, more especially in the departments of Physics, Mechanics, and Astronomy. There are many objects here deserving special mention, but our space forbids further detail. We have already referred to Galileo's instruments, and besides these there are many others of great antiquity and of much interest in connection with the progress of scientific apparatus.

This rapid glance at the contents of the Catalogue will give but a faint idea of the rich feast in store for those who during the next few months will be attracted to the South Kensington galleries. To give anything like an adequate idea of the contents of the collection would take a long series of articles.

We have said that the Catalogue, even in its present incomplete and rough form, is something more than a mere list of titles; it is very largely descriptive. But something more was required to show the purpose and import and historical place of the multitude of separate instruments in the various sections. This want is supplied in the admirable Handbook, of 340 pages, consisting of a series of descriptive and historical articles on the various sections by some of the most eminent living British men of science. It will be enough if we give here the names of the authors and the subjects of which they treat. In value the Handbook should be put alongside the Admiralty Manual issued to the Arctic Expedition; though probably no such unique collection of scientific memoirs was ever before put within reach of the public. The first paper is by Prof. Clerk-Maxwell, being "General Considerations respecting Scientific Apparatus;" Prof. Maxwell has also a paper in his own special domain, Molecular Physics. Prof. H. J. S. Smith writes on "Arithmetical Instruments" and "Geometrical Instruments and Models." Prof. W. K. Clifford also contributes two papers, on "Instruments used in Measurements" and on "Instruments illustrating Kinematics, Statics, and Dynamics." Then there are papers by Dr. W. H. Stone, on "Acoustical Instruments," by Mr. W. Spottiswoode on "Optical Instruments," by Capt. Abney on "Photographic Printing Processes," by Prof. Tait on "Instruments employed in Heat Investigations;" two

papers by Prof. Carey Foster on "Magnetic Apparatus" and "Electrical Instruments;" a paper by Mr. J. Norman Lockyer on "Astronomical Instruments;" by Prof. Goodeve on "Applied Mechanics," by Prof. McLeod on "Chemical Apparatus and Products," by Mr. R. H. Scott on "Meteorological Instruments." "Geographical Instruments and Maps" are illustrated historically and descriptively in four papers by Mr. C. R. Markham, and one by Capt. J. E. Davis. Prof. Geikie treats of "Geology," Mr. Warington Smyth of "Apparatus used in Mining," Prof. Story Maskelyne of "Crystallography and Mineralogy," Prof. Huxley of "Instruments employed in Biological Research," and Mr. H. C. Sorby of "Microscopes." Is not this strong enough evidence of the genuine interest which British men of science take in this Loan Collection of Scientific Apparatus?

There is only one drawback to our joy in seeing this collection at last completed and ready to be thrown open to the public: it is after all only a "loan" collection, and in a few months must be disorganised, and the apparatus returned to their owners. We have some reason to hope, however, that this will not be the end of all the labours of the eminent men who have exerted themselves to make the collection a success; we are persuaded that in time it will be succeeded by a permanent collection, which will form a Science Museum on an equal footing with the other Museums supported by Government. The Introduction to the Handbook says:—

"The Lord-President of the Council, the Duke of Richmond, and the Vice-President, Viscount Sandon, in explaining the objects of the collection, took occasion to refer to the recommendations of the Royal Commission on Scientific Instruction, with regard to the creation of a Science Museum. Their Lordships stated their conviction that the development of the Educational and certain other Departments of the South Kensington Museum, and their enlargement into a Museum somewhat of the nature of the Conservatoire des Arts et Métiers in Paris, and other similar institutions on the Continent, would tend to the advancement of science, and be of great service to the industrial progress of this country."

We cannot doubt that neither Government nor the public, after having substantial evidence of the value and important results of a Science Museum in this Loan Collection, will rest satisfied until this country is at least on an equal footing in this respect with our neighbour France. It seems to us that a permanent Science Museum will be the natural outcome of the unexpectedly magnificent collection which the Queen will open on Saturday; it cannot fail to make the public at large conscious of a serious want which for long has been painfully felt by men engaged in scientific research, both pure and applied.

DIFFUSION OF GASES THROUGH ABSORBING SUBSTANCES

Ueber die Diffusion der Gase durch absorbirende Substanzen. Habilitationsschrift der Mathematischen und Naturwissenschaftlichen Facultät der Universität Strassburg, vorgelegt von Dr. Sigmund v. Wroblewski, erstem Assistanten am physikalischen Institute. (Strassburg: G. Fischbach, 1876.)

THE importance of the exact study of the motions of gases, not only as a method of distinguishing one gas from another, but as likely to increase our knowledge of the dynamical theory of gases, was pointed out by Thomas Graham. Graham himself studied the most important phenomena, and distinguished from each other those in which the principal effect is due to different properties of gases.

The motion of large masses of the gas approximates to that of a perfect fluid having the same density and pressure as the gas. This is the case with the motion of a single gas when it flows through a large hole in a thin plate from one vessel into another in which the pressure is less. The result in this case is found to be in accordance with the principles of the dynamics of fluids. This was approximately established by Graham, and the more accurate formula, in which the thermodynamic properties of the gas are taken into account, has been verified by the experiments of Joule and Thomson. (Proc. R. S., May, 1856.)

When the orifice is exceedingly small, it appears from the molecular theory of gases that the total discharge may be calculated by supposing that there are two currents in opposite directions, the quantity flowing in each current being the same as if it had been discharged into a vacuum.

For different gases the volume discharged in a given time, reduced to standard pressure and temperature, is proportional to—

$$\frac{p}{\sqrt{s\theta}}$$

where p is the actual pressure, s is the specific gravity, and θ the temperature reckoned from $-274°$ C.

When the gases in the two vessels are different, each gas is discharged according to this law independently of the other.

These phenomena, however, can be observed only when the thickness of the plate and the diameter of the aperture are very small.

When this is the case, the distance is very small between a point in the first vessel where the mixed gas has a certain composition, and a point in the second vessel where the mixed gas has a quite different composition, so that the velocity of diffusion through the hole between these two points is large compared with the velocity of flow of the mixed gas arising from the difference of the total pressures in the two vessels.

When the hole is of sensible magnitude this distance is larger, because the region of mixed gases extends further from the hole, and the effects of diffusion become completely masked by the effect of the current of the gas in mass, arising from the difference of the total pressures in the two vessels. In this latter case the discharge depends only on the nature of the gas in the vessel of greater pressure, and on the resultant pressures in the two vessels. It consists entirely of the gas of the first vessel, and there is no appreciable counter current of the gas of the other vessel.

Hence the experiments on the double current must be made either through a single very small aperture, as in Graham's first experiment with a glass vessel accidentally cracked, or through a great number of apertures, as in Graham's later experiments with porous septa of plaster of Paris or of plumbago.

With such septa the following phenomena are observed:—

When the gases on the two sides of the septum are